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though possibly without sufficiently encouraging initiative. The book should be useful in classes somewhat above the grade of the first year in the high school, especially in those laboratories where very full directions are needed. At the same time, it is a question whether the author does not err, in common with many other writers of textbooks of this class, in giving structure complete predominance. In the study of living things it would appear that vital processes and relations should furnish the motive of the course. At any rate, it is scarcely fair to the pupil's perspective to relegate physiology to a few pages, in the nature of an appendix, with occasional references from the body of the text. One would prefer it to be an integral and important part of the laboratory directions.—W. L. EIKENBERRY.

North American flora.[7]—Volume XVI, part I, of this work contains an elaboration of the Ophioglossales-Filicales as follows: Ophioglossaceae by L. M. UNDERWOOD and R. C. BENEDICT; Marattiaceae by L. M. UNDERWOOD; Osmundaceae and Ceratopteridaceae by R. C. BENEDICT; Schizaeaceae, Gleicheniaceae, and Cyatheaceae (pars) by W. R. MAXON. New species are described in the following genera: Ophioglossum (1), Danaea (1), Marattia (1), Aneimia (7), Dicranopteris (1), and Cyathea (4).—J. M. GREENMAN.

NOTES FOR STUDENTS

Chromosome reduction in Oenothera.—DAVIS[8] publishes an account of chromosome reduction in *Oenothera grandiflora* which is a strong confirmation of the earlier work of GEERTS[9] on *O. Lamarckiana*, and of the reviewer on *O. Lamarckiana* and a number of its mutants and hybrids, especially *O. rubrinervis.*[10] As regards the main facts of reduction the results are the same in all three cases, and even many of the finer details of the reviewer's results are here corroborated, though there are evidently certain differences of behavior between *O. Lamarckiana* and *O. grandiflora*, as well as certain differences in interpretation, which will be pointed out.

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[7] North American Flora, Vol. XVI, part I, pp. 1–88. New York Botanical Garden. 1909.

[8] DAVIS, B. M., Cytological studies on Oenothera. I. Pollen development of *Oenothera grandiflora.* Annals of Botany **23**:551–571. *pls. 41, 42.* 1909.

[9] GEERTS, J. M., Beiträge zur Kenntnis der cytologischen Entwicklung von *Oenothera Lamarckiana.* Ber. Deutsch. Bot. Gesells. **26a**:608–614. 1908.

———, Beiträge zur Kenntnis der Cytologie und der partiellen Sterilität von *Oenothera Lamarckiana.* Rec. Travaux Bot. Néerlandais **5**:93–208. *pls. 5–22.* 1909.

[10] GATES, R. R., Pollen development in hybrids of *Oenothera lata* × *O. Lamarckiana,* and its relation to mutation. BOT. GAZETTE **43**:81–115. *pls. 2–4.* 1907.

———, Hybridization and germ cells of *Oenothera mutants.* BOT. GAZETTE **44**:1–21. *figs. 3.* 1907.

———, A study of reduction in *Oenothera rubrinervis.* BOT. GAZETTE **46**:1–34. *pls. 1–3.* 1908.

———, The behavior of chromosomes in *Oenothera lata* × *O. gigas.* BOT. GAZETTE **48**:179–199. *pls. 12–14.* 1909.

The present account substantiates the earlier one in two fundamental points: (1) in synapsis the nuclear reticulum contracts into a ball, during which a more or less continuous thread is formed, but there is no evidence of a pairing of separate threads; (2) the thick spirem finally segments in such a way as to show that the chromosomes must have been arranged in a single series end-to-end. These are the two essentials of the method of heterotypic chromosome formation according to the account of FARMER and MOORE, MOTTIER, and others.

The author of the paper under review was formerly a strong advocate of the method of reduction by a lateral pairing of spirems previous to synapsis. This fact, together with the fact that he is the third investigator who has now given the same account as regards the essential points of chromosome reduction in Oenothera, places practically beyond question the presence of a telosynapsis (end-to-end pairing) instead of a parasynapsis (side-by-side pairing) in this genus.

In the nature of things, a lateral pairing of delicate threads previous to synapsis is more difficult to demonstrate than the cross-segmentation of a thick spirem after synapsis (see GATES **'08,** *figs. 22–26*). But ROSENBERG has reiterated his belief in a parasynapsis in Drosera; and has recently[11] brought forward some particularly clear evidence of a lateral pairing in that genus. A number of other investigators have given more or less convincing evidence of a parasynapsis in other forms. In the light of these facts it seems pretty evident that both these general methods of reduction occur in plants, a view which I have advanced in former papers. When cytologists become ready to admit that the evident differences in accounts of reduction are not all differences of interpretation, but are in many cases differences in fact, we shall have taken a forward step in the science and shall be ready to attack the problem of the meaning of the differences in chromatin behavior involved. To admit that *all* differences in accounts are due to real differences in chromatin behavior, would introduce laxity into interpretations which must necessarily always be critical, but nevertheless it must be admitted that in some of the more recent papers, clear and important differences in the method of the chromatin behavior have been established.

Several differences between DAVIS'S account of reduction in *O. grandiflora* and my account of that process in the *O. Lamarckiana* forms may now be pointed out. They are partly differences of interpretation and partly differences of fact. DAVIS states that the chromatic bodies in the resting nuclei are probably prochromosomes, but this is evidently the statement of a pious wish rather than an observation of fact, for he himself finds variation in the size and number of such bodies. He has unfortunately failed to distinguish between the true synapsis or synizesis, which is familiar to all cytologists as the stage in which the thin and delicate spirem is contracted into a ball, and the second contraction phase,

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[11] ROSENBERG, O., Cytologische und morphologische studien über *Drosera longifolia rotundifolia*. Kungl. Svenska Vetenskapsakad. Handl. **43**:1–64. *pls. 1–4.* 1909.

which comes much later in the history of reduction, after the spirem has undergone an enormous amount of shortening and thickening. In Oenothera it is a well-marked stage, immediately preceding the transverse segmentation of the spirem to form chromosomes; and separated from synizesis by a long interval, during which the spirem loosens its coils, enabling the rearrangement and thickening of the threads to go on.

The author's account of the heterotypic chromosomes in *O. grandiflora* shows an evident difference between this species and the *O. Lamarckiana* forms. In the former, rings are said always to be produced, although no adequate evidence of their method of origin is presented. While it is probable that many of the rings figured are really open at one end, or with the chromosomes merely in contact and not fused, yet a comparison of DAVIS's *figs. 27–30* with my *figs. 26–34* (*O. rubrinervis*, **'08**) shows that evidently the attraction which leads a chromosome to pair with its mate is greater in *O. grandiflora* than in *O. Lamarckiana* forms. This condition in *O. Lamarckiana* forms may have come about as a result of conditions of cultivation or hybridization, and, as I have pointed out elsewhere, may be directly connected with the mutation phenomena in *O. Lamarckiana.* Whether or not this is the case, I have shown that, as a result of this weak attraction between chromosomes, irregularities in chromosome distribution during reduction actually do occur.—R. R. GATES.

Cytology of the ascus.—BLACKMAN and Miss FRASER,[12] and more recently Miss FRASER[13] and Miss WELSFORD,[14, 15] have concluded that in *Humaria granulata*, *Ascobolus furfuraceus*, and *Lachnea stercorea* a normal sexual process does not obtain. Instead of a fusion of sexual nuclei in the oogonium, a reduced sexual process occurs in which the female nuclei fuse in pairs with a subsequent asexual fusion in the ascus.

Still more recently FRASER and BROOKS[16] have studied further the process of nuclear division, methods of chromosome reduction, and spore formation in the above-mentioned pseudo-apogamous forms. They find in each of these plants two sorts of reducing divisions occurring in the ascus. The first two divisions are heterotypic and homeotypic respectively, and thus bring about a chromosome reduction in the manner described for higher plants. They regard this type of reduction as being associated with fertilization or its equivalent. The third

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[12] BLACKMAN, V. H., AND FRASER, HELEN C. I., On the sexuality and development of the ascocarp of *Humaria granulata.* Proc. Roy. Soc. London B **77**:354–368. 1906.

[13] FRASER, HELEN C. I., On the sexuality and development of the ascocarp of *Lachnea stercorea.* Annals of Botany **21**:349–360. 1907.

[14] WELSFORD, E. J., Fertilization in *Ascobolus furfuraceus.* New Phytol. **7**:156–161. 1907.

[15] FRASER, H. C. I., AND WELSFORD, E. J., Further contributions to the cytology of the Ascomycetes. Annals of Botany **22**:465–477. 1908.

[16] FRASER, H. C. I., AND BROOKS, W. E. ST. J., Further studies on the cytology of the ascus. Annals of Botany **23**:537–549. 1909.